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(71) Applicant: IMPLANT INNOVATIONS, INC. [US/US]; 4555 Riverside Drive, Palm Beach Gardens, FL 33410 (US).

(72) Inventors: BEATY, Keith; 16 Riverside Drive West, Jupiter, FL 33469 (US). BROWN, Gale; 4461 S.W. Bimini Circle North, Palm City, FL 34990 (US). LAZZARA, Richard; 1814 North "R" Street, Lake Worth, FL 33460 (US). PORTER, Stephan; 178 Bent Tree Drive, Palm Beach Gardens, FL 33418 (US). ROGERS, Dan, Paul; 10107 Yeoman Lane, Royal Palm Beach, FL 33411 (US). SULLIVAN, Daniel; 1029 Broad Branch Court, McLean, VA 22101 (US).

(74) Agent: GATZ, John; Arnold, White & Durkee, P.O. Box 4433, Houston, TX 77210 (US).

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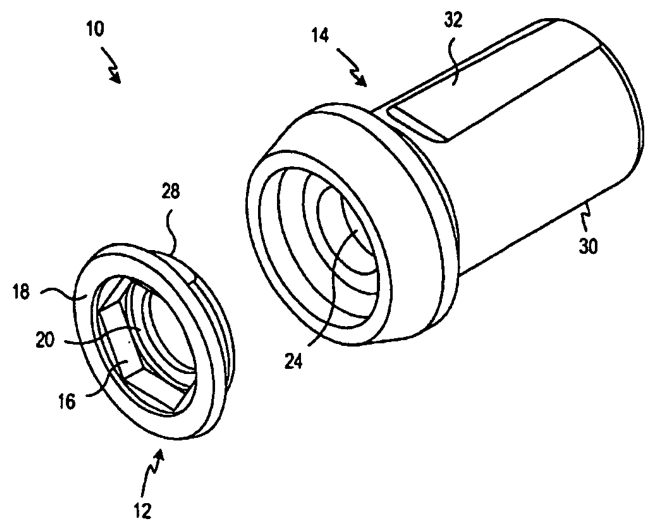

(57) Abstract

A support post for use with a dental implant comprising a ceramic portion, a screw, and a metal portion. The ceramic portion is adapted to support a prosthesis thereon. The ceramic portion has a supragingival region for protruding beyond the gingiva and a subgingival end for extending into the gingiva. The ceramic portion has a passageway extending therethrough. According to one embodiment, the passageway narrows to form a shoulder that is made entirely of ceramic. The screw is adapted to engage an internally threaded bore in the implant and be insertable through the passageway. The screw comprises a head and a threaded section. The head of the screw seats entirely on the shoulder. The metal portion comprises a lower section and an upper section extending into the passageway. The metal portion abuts the subgingival end of the ceramic portion. The lower section is adapted to receive and engage the corresponding boss of the dental implant. The metal portion has an opening to provide access to the screw.

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CERAMIC DENTAL ABUTMENTS WITH A METALLIC CORE

FIELD OF THE INVENTION

This invention generally relates to a support post for use with a dental implant and adapted to support a prosthesis thereon. Specifically, the support post is comprised of a ceramic portion and a metal portion.

BACKGROUND OF THE INVENTION

Surgical techniques for support of dental prostheses by means of metallic bone-embedded artificial root fixtures are well known. According to one prior art technique, a titanium bone-embedded implant fixture is interfaced with a metallic abutment post on which a superstructure, such as a prosthesis, is supported. The post has an internally shouldered access bore through which a screw is inserted to hold the implant and the post assembled. A number of problems and restrictions are presented, however, in the attachment and retention of the superstructures to such abutment posts.

Specifically, the typical superstructures for use with such posts are made of porcelain. The use of a titanium post generally results in a dark, central rod-like shadow, particularly when exposed to bright light, which makes the prosthesis somewhat unattractive since it is distinguishable from a natural tooth. Further, since the materials are different, sometimes there are problems with securing the prosthesis to the support post.

One attempt to solve the attractiveness and securement problems involves making a support post entirely of ceramic material, specifically, aluminum oxide. This approach allows direct surface bonding by interaction of a porcelain coping and/or prosthesis to the support post, resulting in a secure and almost seamless bond between the prosthesis and support post. While presenting an alternative attraction to the use of a titanium support post, the proposed solution presents a number of problems.

Ceramic materials generally have a much greater hardness than titanium. When a ceramic support post is used, inevitable rocking of the support post due to, for example, chewing, causes a high stress interaction between the metal implant and the ceramic material of the post. Since a ceramic support post is of greater hardness than a titanium implant, it can and does cause damage to the implant. If sufficient damage is caused, eventual surgical intervention is required to remove and replace the titanium implant. In

addition, ceramic material is typically not radiopaque. Thus, when examining the juncture between the support post and the titanium implant through conventional dental x-ray imaging, the interface between the two elements is not readily viewable and, thus, adequate x-ray examination cannot be conducted.

SUMMARY OF THE INVENTION

The present invention is a support post for use with a dental implant. The support post comprises a ceramic portion, a screw, and a metal portion. The ceramic portion is adapted to support a prosthesis thereon. The ceramic portion has a supragingival region for protruding beyond the gingiva and a subgingival end for extending into the gingiva. The ceramic portion has a passageway extending therethrough. According to one embodiment of the present invention, the passageway narrows to form a shoulder that is made entirely of ceramic.

The screw is adapted to engage threads of an internally threaded bore in the implant and be insertable through the passageway. The screw comprises a head and a threaded section. The head of the screw seats entirely on the shoulder.

The metal portion comprises a lower section and an upper section extending into the passageway. The metal portion abuts the subgingival end of the ceramic portion. The lower section is adapted to receive and engage a corresponding boss of the dental implant. The metal portion has an opening to provide access to the screw.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings.

FIG. 1 is an exploded perspective view of a support post including a metal portion and a ceramic portion according to one embodiment of the present invention.

FIG. 2 is a side cross-sectional view of a support post of FIG. 1.

FIG. 3 is a cross-sectional view of a support post of FIG. 2, a dental implant, and an abutment screw according to one embodiment of the present invention.

FIG. 4 is a side cross-sectional view of the metal portion of FIG. 1.

FIG. 5 is a top plan view of the metal portion of FIG. 4.

FIG. 6 is a bottom plan view of the metal portion of FIG. 4.

FIG. 7 is a side cross-sectional view of the ceramic portion of FIG. 1.

FIG. 8 is a top plan view of the ceramic portion of FIG. 7.

FIG. 9 is a bottom plan view of the ceramic portion of FIG. 7.

FIG. 10 is an exploded perspective view of a support post including a metal portion and a ceramic portion according to another embodiment of the present invention.

FIG. 11 is a side cross-sectional view of a support post of FIG. 10.

FIG. 12 is an exploded perspective view of a support post including a metal portion and a ceramic portion according to yet another embodiment of the present invention.

FIG. 13 is a side cross-sectional view of a support post of FIG. 12.

FIG. 14 is a side cross-sectional view of the metal portion of FIG. 12.

FIG. 15 is a top plan view of the metal portion of FIG. 14.

FIG. 16 is a bottom plan view of the metal portion of FIG. 14.

FIG. 17 is a side cross-sectional view of the ceramic portion of FIG. 12.

FIG. 18 is a top plan view of the ceramic portion of FIG. 17.

FIG. 19 is a bottom plan view of the ceramic portion of FIG. 17.

FIG. 20 is a longitudinal cross-section of a tubular abutment which is made primarily of a ceramic material.

FIG. 21 is a longitudinal cross-section of an abutment which is made primarily of a ceramic material.

FIG. 22 is yet a further alternative abutment which is made primarily of a ceramic material.

FIG. 23 is yet another alternative abutment which is made primarily of a ceramic material.

While the invention is susceptible to various modifications and alternative forms, a specific embodiment thereof has been shown by way of example in the drawing and will herein be described in detail. It should be understood, however, that it is not intended to limit the invention to the particular forms disclosed but, on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Referring now to the drawings in detail, FIG. 1 shows an exploded perspective view of a support post 10 that is adapted for use with a dental implant. The support post

10 comprises a metal portion 12 and a ceramic portion 14. FIG. 2 shows a cross-sectional view of the metal portion 12 and the ceramic portion 14 attached together. The metal portion 12 is adapted to receive and engage a dental implant, such as dental implant 50 in FIG. 3. The metal portion 12 of FIGS. 1-3 is shown in more detail in FIGS. 4-6. The ceramic portion 14 is adapted to support a prosthesis thereon (not shown). The ceramic portion 14 of FIGS. 1-3 is shown in more detail in FIGS. 7-9.

Referring to FIGS. 4-6, the metal portion 12 comprises a lower section and an upper section. The lower section of the metal portion 12 comprises a polygonal socket 16 (*e.g.*, a hexagon) and an outwardly extending flange 18 extending from the polygonal socket 16. The upper section of the metal portion 12 comprises an inwardly extending section 20 extending from the polygonal socket 16. The polygonal socket 16 is adapted to receive and engage a corresponding boss 54 on a gingival end of the dental implant 50 (see, *e.g.*, FIG. 3). The shapes of the polygonal socket 16 and the corresponding polygonal boss 54 inhibit rotation of the support post 10 relative to the dental implant. Referring to FIGS. 3 and 4, the flange 18 has an exterior surface that tapers inwardly toward the dental implant 50. A subgingival end of the ceramic portion 14 has an outer surface that generally follows a contour of the exterior surface of the flange 18.

The metal portion 12 is typically located in a subgingival section (*i.e.*, a section below the gingival surface) so as to enhance the aesthetics of the prosthesis. The length L1 of FIG. 4 is generally from about 1.5 mm to about 3 mm. The length L1 is preferably less that about 3 mm so as to remain below a gingival surface.

The metal portion 12 also includes a generally flat surface 28 (see FIGS. 1 and 5) to assist in inhibiting or preventing rotation of the metal portion 12 relative to the ceramic portion 14. The metal portion 12 is preferably located in a subgingival section (*i.e.*, a section below the gingival surface) so as to enhance the aesthetics of the prosthesis. This is shown, for example, in FIG. 3 where the metal portion 12 is below a gingival surface 57.

To provide access for a screw that engages threads of an internal bore in the dental implant, the metal portion 12 has a central opening 22. As shown in FIGS. 2 and 3, the central opening 22 extends upwardly into a central passageway 24 of the ceramic portion 14. Referring specifically to FIG. 3, a screw 60 is shown extending through the central opening 22. The screw 60 includes a head 62 and a lower section 64 having

external threads thereon. The screw 60 is threaded into an internally threaded bore 52 of the dental implant 50. The screw 60 secures the support post 10 and the dental implant 50. The dental implant 50 also has threads 56 for engaging the jawbone (including the maxillary and mandible). The dental implant 50 is substantially located below a gingival surface 57 and contacts a jawbone (not shown). The jawbone is located below a bone tissue surface 59. The length L3 between the gingival surface 57 and the bone tissue surface 59 is generally about 3 mm.

Referring to FIGS. 7-9, the ceramic portion 14 includes a supragingival section 70 that protrudes beyond the gingiva, and a subgingival section 72 for extending into the gingiva. The supragingival section 70 includes a generally cylindrical section 30. The generally cylindrical section 30 of the ceramic portion 14 is adapted to engage a prosthesis (not shown). The generally cylindrical section 30 may be formed into other shapes.

The generally cylindrical section 30 has a generally flat surface portion 32. The surface portion 32 is generally rectangular in shape (see FIG. 1), but may be formed in other shapes, such as, for example, a triangular shape. The surface portion 32 inhibits rotation of a prosthesis (not shown) relative to the support post 10. Specifically, rotation is inhibited or prevented when an adhesive is added to secure a placed prosthesis to the ceramic portion 14. The adhesive is placed in a space formed between an interior surface of a prosthesis and the surface portion 32.

Alternatively, a prosthesis may be formed by building up porcelain. According to one process, the abutment is altered by prepping with a bur to reproduce a shape and gingival contours of the tooth being replaced. The process begins by building an adaptable type of porcelain on an abutment in rough form and bake. The prosthesis is refined by grinding the contours and the occlusal anatomy to match adjacent teeth on a model. The anatomic shape and contours of the model are verified. The porcelain may be stained to match the color of the adjacent teeth and is typically glazed and polished before delivering.

Additionally, the generally cylindrical section 30 may be tapered slightly to further aid in installing and securing a prosthesis to the support post 10. For example, the generally cylindrical section 30 may be tapered at a pitch of about three degrees.

Optionally, the generally cylindrical section 30 may have a groove (not shown) or other means for securing a set screw used to hold a prosthesis in place.

The exterior surface of the generally cylindrical section has a rounded shoulder 36. The rounded shoulder 36 is connected to a generally cylindrical exterior surface 37 that extends generally in a downward direction towards a dental implant. The generally cylindrical exterior surface 37 is connected to a tapered surface 38 that extends inwardly and downwardly towards a dental implant.

Referring specifically to FIG. 7, the ceramic portion 14 is hollow with the central passageway 24 therethrough. At a distal end of the ceramic portion 14, there is an open end which allows a screw to enter into the support post 10. The central passageway 24 narrows to form a shoulder 26 that provides a seat for a screw, such as the head 62 of the screw 60 as shown in FIG. 3. Specifically, the central passageway 24 has a generally horizontal surface defining the shoulder 26. The shoulder 26 of FIG. 7 is made entirely of ceramic.

The length L4 of FIG. 7 may be varied to accommodate differing patient's anatomies. For example, if a patient has a greater gingiva height, the length L4 may be increased. The length L4 is generally from about 2.0 mm to about 4.0 mm. The length L4 may, however, be less than 2.0 mm and greater than 4.0 mm. The length L4 is preferably from about 2 mm to about 3 mm. The length L4 is preferably less than about 3 mm so as to be aesthetically pleasing by remaining below the gingival surface.

The width W1 of FIG. 7 may also vary to accommodate differing patient's anatomies. To provide improved support to the support post, the width W1 is generally selected to correspond to the flange 18 of the metal portion 12. The width W1 is generally from about 3 mm to about 6 mm. The width W1 may, however, be less than 3 mm and greater than 6 mm. A width W2 is generally selected to correspond to the size of the prosthesis and the space between the teeth. The width W2 is typically greater than the width W1. The width W2 is generally from about 5 mm to about 7 mm. The width W2 may, however, be less than 5 mm and greater than 7 mm.

The metal portion 12 is engaged to the ceramic portion 14. Referring back to FIGS. 1 and 2, an exterior surface of the metal portion 12 abuts a corresponding interior surface of the ceramic portion 14 at the subgingival end of the ceramic portion 14. The ceramic portion 14 preferably does not abut a dental implant (see, *e.g.*, FIG. 3).

The metal portion 12 may be engaged to the ceramic portion 14 by a variety of methods. For example, the metal portion 12 may be secured by adhesives to the ceramic portion 14. Some types of adhesives that may be used are conventional cements or ceramic sealants, such as a ceramic sealing glass. The selected adhesive is preferably not affected by temperatures associated with forming a prosthesis by building up porcelain.

The metal portion 12 and the ceramic portion 14 of FIGS. 1 and 2 may also receive assistance by a screw in their engagement. If a screw seats entirely on a metal portion, then the metal portion and ceramic portion would be held in place, *e.g.*, by only an adhesive.

It is contemplated that other dental adhesives may be used to secure the metal portion 12 to the ceramic portion 14. To form an improved surface for adhesion, the metal portion 12 may be grip-blasted by, for example, air pressure. Alternatively, the metal portion 12 may be made so as to be press-fitted into the ceramic portion 14.

According to one process for securing the metal portion 12 to the ceramic portion 14, ceramic sealing glass is applied to either an exterior surface of the metal portion 12, an interior surface of the ceramic portion 14, or a combination thereof. The metal portion 12 is placed into the interior surface of the ceramic portion 14. The metal portion 12 and the ceramic portion 14 are heated to a temperature sufficient to melt the ceramic sealing glass. The metal portion 12 and the ceramic portion 14 are cooled to a temperature sufficient so as to secure the metal portion 12 to the ceramic portion 14.

Referring to FIGS. 1 and 4, the generally flat surface 28 of the metal portion 12 assists in inhibiting or preventing rotation of the metal portion 12 relative to the ceramic portion 14. Specifically, a space 29 is formed between the ceramic portion 14, and the flat surface 28 of the metal portion 12 receives an adhesive to inhibit or prevent rotation of the metal portion 12 and the ceramic portion 14. If the metal portion 12 and the ceramic portion 14 are press fit, the flat surface 28 of the metal portion 12 does not inhibit or prevent rotation unless a second corresponding generally flat surface (not shown) is formed on an interior surface of the ceramic portion 14.

The metal portion 12 is generally comprised of titanium or a titanium alloy. Other biocompatible materials may be used in forming the metal portion, such as gold alloys, cobalt chrome, and the like. The metal portion 12 may be made of any other medically compatible material having a similar hardness to the hardness of the material

used in forming the dental implant. For example, the metal portion 12 may be comprised of Ti-6Al-4V (90 wt% titanium, 6 wt% aluminum, and 4 wt% vanadium) and the dental implant may be comprised of commercially pure titanium or Ti-6Al-4V. The material used to form the metal portion 12 is preferably radiopaque (*i.e.*, opaque to x-rays) so that the interface between the metal portion 12 and a dental implant can be examined.

The ceramic portion 14 may be made entirely of a ceramic material, such as aluminum oxide (alumina). Alternatively, the ceramic portion may be comprised of zirconium oxide (zirconia). The ceramic material may include coloring, such as the natural color of a tooth. To assist in stabilizing the ceramic material, materials, such as hafnium oxide and/or yttrium oxides (yttria), may be added. It is contemplated that additional oxide(s) may be used in forming the ceramic portion 14. In one embodiment, the ceramic portion 14 comprises from about 92 wt% to about 99 wt% zirconium oxide, from about 4.5 wt% to about 5.4 wt% yttrium oxide, from about 0 wt% to about 0.5 wt% hafnium oxide, from about 0 wt% to about 0.5 wt% aluminum trioxide, and from about 0 wt% to about 0.5 wt% of other oxides. The ceramic portion may be made from a material that is radiopaque. The hardness of the material used in forming the ceramic portion is greater than the hardness of the material used in forming the dental implant.

A ceramic portion made from yttria-stabilized zirconium oxide generally has a greater fracture toughness and flexural strength than a ceramic portion of aluminum oxide. It is desirable to have a higher fracture toughness and flexural strength because the ceramic portion is stronger, tougher, and more durable. Also, using a material having a higher fracture toughness and flexural strength may result in faster preparation of the support post if the shaping process can occur at a higher temperature because the material is less likely to chip or crack.

As discussed above, the widths W2 and W1 of the support post 10 may be varied. This is shown, *e.g.*, in FIGS. 10 and 11 where, in another embodiment of a support post (support post 110), the width W3 is greater as compared to the width W1 shown in FIG. 7. Likewise, the width W4 of FIG. 10 is greater than the width W2 shown in FIG. 7. The support post 110 is similar to the support post 10 depicted in FIGS. 1 and 2. The support post 110 includes a metal portion 112 and a ceramic portion 114. The ceramic portion 114 has a surface portion 132 which is a truncated triangle shape.

FIGS. 12-19 illustrate yet another embodiment of a support post (support post 210) to be engaged to an implant and adapted to support a prosthesis thereon. The support post 210 is similar to the support post 10 depicted in FIGS. 1 and 2, except that a generally tubular section 220 has a greater length L5 than a corresponding length L2 of the metal portion 12 (see FIG. 4). The support post 210 of FIGS. 12 and 13 includes a metal portion 212 and a ceramic portion 214.

Referring to FIGS. 14-16, the metal portion 212 comprises a polygonal socket 216, an outwardly extending flange 218 extending from the polygonal socket 216, and the generally tubular section 220 extending above the polygonal socket 216. The generally tubular section 220 has an upper surface 221. At least a portion of the upper surface 221 forms a shoulder that provides a seat for a head of a screw (not shown). The portion of the upper surface 221 forming the shoulder is made entirely of metal. To provide access for a screw to reach internal threads in the dental implant, the metal portion 212 has a central opening 222. The metal portion 212 may be located in a subgingival section (*i.e.*, a section below the gingival surface) so as to enhance the aesthetics of the prosthesis. The length L6 is generally from about 1.5 mm to about 4 mm and, more specifically, from about 2 mm to about 3 mm. The length L6 is preferably less that about 3 mm so as to remain below a gingival surface.

Another embodiment of the ceramic portion is shown in FIGS. 17-19. The ceramic portion 214 differs from the ceramic portion 14 by, *e.g.*, not forming a shoulder to seat the screw. The ceramic portion 214 of FIGS. 17-19 is adapted to engage the metal portion 212.

The ceramic portion 214 of FIGS. 17-19 includes a supragingival section 270 (*i.e.*, a section above the gingival surface) and a subgingival section 272 (*i.e.*, a section below the gingival surface). The ceramic portion 214 is hollow with a central passageway 224 therethrough. The central passageway 224 widens at an internally rounded shoulder 225 in a generally horizontal direction before proceeding in a generally vertical direction.

FIGS. 20-23 illustrate various alternative abutments which are made primarily of ceramic. The abutments in FIGS. 20-23 are aesthetically pleasing since the ceramic material is a lighter color which is not readily seen through the gingival tissue.

In FIG. 20, a ceramic abutment 300 includes a ceramic outer piece 302 surrounding a metallic core 304. The metallic core 304 include a socket 312 which engages the hexagonal boss of an implant. The metallic core 304 also has a lower surface 316 for engaging the annularly-shaped surface which surrounds the hexagonal boss on the top of the implant. The ceramic outer piece 302 includes a lower section 314 which tapers upwardly away from the lower end 316 and terminates at a shoulder 320. Above the shoulder 320 is an upper section 318 of the ceramic outer piece 302 which decreases in cross-section as it proceeds away from the shoulder 320 toward the uppermost end of the ceramic abutment 300.

The lower surface 317 of the ceramic outer piece 302 preferably engages the upper surface of the lower end 316 of the metallic core 304. Consequently, the upper surface of the implant only engages the metallic core 304 and does not engage the ceramic outer piece 302. This ensures that the ceramic outer piece 302, which is usually a harder material than the titanium implant, does not mar the implant. In one preferred embodiment, the metallic core 304 is made of titanium while the ceramic outer piece 302 is made of aluminum oxide. In addition to aluminum oxide, the ceramic outer piece 302 can also be made of zirconium.

The metallic core 304 includes a tapered surface 322 for engaging a corresponding taper on a post, such as the post 335 in FIG. 21. Thus, angle α of post 335 in FIG. 21 is the substantially the same as angle α in tapered surface 322 of ceramic abutment 300 of FIGS. 20 and 21. The tapered surface 322 may be made to be a locking taper. The angle α is generally in the range from about 5° to about 20°. Because the post 335 is usually made of a metal (e.g. titanium), it is preferable for the locking taper 322 to also be made of metal. If the locking taper is made of a hard ceramic, then the engagement of the ceramic locking taper and the post may result in a high coefficient of friction. Higher insertion torques would then be needed to result in the same amount of tension in the post (i.e., the force holding the ceramic abutment 300 on the implant) which is brought about through the threaded engagement of the lower stem of the post and the internal bore of the implant. Additionally, the hardness of the ceramic locking taper may cause it to mar on the surface of the titanium post. However, it is possible to provide a biocompatible lubricant to reduce friction if a ceramic metal is used.

While FIG. 20 illustrates the metallic core extending to the uppermost end of the abutment 300, it may extend to a point where the tapered surface is below the uppermost end. However, enough material should be present to perform the locking function with the post.

In one embodiment, the metallic core 304 is pressfit into the ceramic outer piece 302. One way to achieve this pressfit engagement is by cooling the metallic core 304 such that it decreases in cross-sectional size due to its coefficient thermal expansion and allowing it to heat up to room temperature whereby it expands into a tight engagement with the ceramic outer piece 302. Additionally, the metallic core 304 can be attached to the ceramic outer piece 302 through an adhesive.

FIG. 21 illustrates an alternative ceramic abutment 330 which includes a ceramic outer piece 332 and a metallic core 334. Instead of the metallic core 334 extending entirely to the uppermost surface of the ceramic abutment 330, the metallic core 334 is only placed inside the ceramic outer piece 302 at its lower end to form a non-round (e.g. hexagonal) socket. Because it is preferable to have the tapering section of the post 335 engage a metallic surface, instead of a ceramic surface, a metallic foil 340 is placed into the ceramic outer piece 302 prior to insertion of the post. The foil 340 has a frusto-conical shape such that fits within the tapered aperture of the ceramic outer piece 332. Thus, as the post 335 is threaded into the ceramic abutment 330, the tapering section of the post engages the metallic foil 340 which reduces the torque required to overcome the frictional engagement at the locking taper surface. The foil 340 can be made of gold or a gold alloy.

FIG. 22 is very similar to FIG. 21 in that a ceramic abutment 350 includes a ceramic outer piece 352 and a lower metallic core 354. Additionally, the ceramic abutment 350 in FIG. 22 includes an upper metallic core 356 which fits into the ceramic outer piece 352 thereby forming a metallic tapering surface for the ceramic abutment 350 which engages a corresponding tapering section of the post. In comparison with FIG. 20 which has a unitary metallic core 304, FIG. 22 has two metallic metallic cores for accomplishing the same purpose. By separating the metallic core into two pieces, varied internal configurations are available for the ceramic outer piece 332 since the two metallic pieces 354 and 356 can be inserted from both ends. This is different than the configuration of FIG. 20 where the ceramic portion has a smooth, continuous opening to

receive the smooth continuous external surface of the metallic core. The lower metallic core 354 and upper metallic core 356 can again be pressfit into engagement with the ceramic outer piece 352 or attached thereto the end via an adhesive.

The ceramic abutment 360 of FIG. 23 includes a ceramic outer piece 362 and upper and lower metallic cores 364 and 366. Thus, the metallic cores 364 and 366 are very similar to the metallic cores described in FIG. 22. The primary difference between the ceramic abutment 360 in FIG. 23 and the ceramic abutment 350 in FIG. 22 is that the ceramic abutment 360 has a different exterior configuration brought about through the configuration of the ceramic outer piece 362. While the ceramic outer piece 362 has a circular cross-sectional configuration, the ceramic outer piece 362 could also be manufactured to have a non-round cross-section such that it would closely match the contour of a natural tooth as it emerged through the gum tissue.

While the ceramic abutments shown in FIGS. 20-23 having been described as being produced through the mechanical attachment of a metallic core to a ceramic outer piece, other possibilities exist for resulting in the same configuration. For example, the ceramic material (e.g. aluminum oxide) can be grown onto the metallic core. One such process entails having the ceramic vaporized and deposited onto the metallic core through a process known as physical vapor synthesis. Such a process is described in the article entitled "Creating Nanophase Materials," by Siegel in Scientific American, December 1996, Vol. 275, No. 6, pp. 74-79, which is herein incorporated by reference in its entirety. The result of such a process is a very durable ceramic formed on the metallic core.

While the present invention has been described with reference to one or more particular embodiments, those skilled in the art will recognize that many changes may be made thereto without departing from the spirit and scope of the present invention. Each of these embodiments and obvious variations thereof is contemplated as falling within the spirit and scope of the claimed invention, which is set forth in the following claims.

WHAT IS CLAIMED IS:

1. A support post for use with a dental implant, said dental implant having an internally threaded bore and a boss located on a gingival end, said implant being substantially located below an exterior surface of the gingiva and contacting a jawbone, said support post comprising:

a ceramic portion for supporting a prosthesis, said ceramic portion having a supragingival region for protruding beyond said gingiva and a subgingival end below said supragingival region, said ceramic portion having a passageway extending therethrough;

a metal insert extending into said passageway and engaging said subgingival end of said ceramic portion, said metal insert having a lower portion for engaging said dental implant, an upper portion forming a socket for engaging said corresponding boss, and an opening therethrough, said upper portion having an uppermost surface; and

a screw adapted to engage said internal threads in said implant, said screw extending through said opening and a head of said screw residing above said uppermost surface of said upper portion of said metal insert.

2. The support post of Claim 1, wherein said passageway narrows to form a shoulder, and said screw comprises a head and a threaded section, said head of screw seats entirely on said shoulder.

3. The support post of Claim 2, wherein said shoulder is made entirely of ceramic.

4. The support post of Claim 1, wherein an uppermost surface of said metal insert forms a shoulder and said screw seats entirely on said uppermost surface of said metal insert.

5. The support post of Claim 1, wherein said passageway of said ceramic portion forms a tapered surface for engaging said head of said screw.

6. The support post of Claims 2-5, wherein said ceramic portion is comprised of aluminum oxide, zirconium oxide, or a combination thereof.

7. The support post of Claim 6, wherein said ceramic portion further includes hafnium oxide, yttrium oxide, or a combination thereof.

8. The support post of Claims 2-5, wherein said metal insert is comprised of titanium, a titanium alloy, a gold alloy or cobalt chrome.

9. The support post of Claims 2 and 3, wherein said passageway includes a generally horizontal surface defining said shoulder.

10. The support post of Claim 1, wherein said lower portion of said metal insert comprises a flange.

11. The support post of Claim 10, wherein said flange has an exterior surface, said exterior surface tapering inwardly toward said dental implant.

12. The support post of Claim 11, wherein said subgingival end of said ceramic portion has an outer surface generally following a contour of said exterior surface of said flange.

13. The support post of Claim 1, wherein said upper portion of said metal insert is generally tubular.

14. The support post of Claim 4, wherein said head is enlarged and extends above said ceramic portion.

15. The support post of Claim 4, wherein at least a portion of said passageway is defined by said tapered surface that tapers inwardly at a predetermined angle with respect to a central axis in a direction toward said implant and wherein said screw includes an outer surface with a tapered portion that tapers at an angle substantially the same as said predetermined angle for engaging said tapered surface of said passageway.

16. The support post of Claim 15, wherein said predetermined angle is in the range from about 5° to about 20°.

17. The support post of Claim 4, wherein said tapered surface is a locking tapered surface.

18. A method of forming a support post for use with a dental implant, said support post having a ceramic portion adapted to support a prosthesis and a metal insert adapted to receive and engage said dental implant, said ceramic portion having an interior surface and an exterior surface, said metal insert having an interior surface and an exterior surface, said interior surface of said ceramic portion generally corresponding to said exterior surface of said metal insert, said method comprising:

(a) applying a ceramic sealant to said exterior surface of said metal insert, said interior surface of said ceramic portion, or a combination thereof;

(b) placing said metal insert into said interior surface of said ceramic portion;

(c) heating said metal insert and said ceramic portion to a temperature sufficient to melt said ceramic sealant; and

(d) cooling said metal insert and said ceramic portion to a temperature sufficient so as to secure said metal insert and said ceramic portion.

19. The method of Claim 18, wherein said ceramic sealant is a ceramic sealant glass.

20. A support post for use with a dental implant, said dental implant having an internally threaded bore and a non-round fitting located at a gingival end portion thereof, said implant being substantially located below an exterior surface of the gingiva and contacting a jawbone, said support post comprising:

a ceramic portion for supporting a prosthesis, said ceramic portion having a supragingival region for protruding beyond said gingiva and a subgingival end below said supragingival region, said ceramic portion having a passageway extending therethrough, said passageway narrowing to form a shoulder, said shoulder being made entirely of ceramic;

a screw adapted to engage threads of said internally threaded bore in said implant and insertable through said passageway, said screw comprising a head and a threaded section, said head of said screw seats entirely on said shoulder; and

a metal portion extending into said passageway and engaging said subgingival end of said ceramic portion, said metal portion having a lower section for engaging said corresponding non-round fitting of said dental implant and an opening to provide access to said screw.

21. The support post of Claim 20, wherein said ceramic portion is comprised of aluminum oxide, zirconium oxide, or a combination thereof.

22. The support post of Claim 20, wherein said non-round fitting is a boss.

23. A prosthesis support post for use with a dental implant positioned below an exterior surface of the gingiva and contacting bone, said implant having a gingival end, said support post comprising:

a metal portion for engaging said gingival end of said implant and including a flange;

a generally tubular ceramic portion having a lower internal cavity into which at least a part of said metal portion is received, said ceramic portion including a subgingival

end engaging said flange and a supragingival region for protruding beyond said gingiva; said ceramic portion having an internal shoulder residing above said lower internal cavity; and

a screw for extending through said ceramic portion and for said support post on said implant, said screw seating on said shoulder.

24. A support post for use with a dental implant, said dental implant having an internally threaded bore and a non-round fitting on a gingival end portion thereof, said implant being substantially located below an exterior surface of the gingiva and contacting a jawbone, said support post comprising:

a ceramic portion having an upper portion, a lower portion and a passageway extending therethrough, said passageway narrowing to form a shoulder;

a metal insert residing in said passageway of said lower section of said ceramic portion and being entirely below said shoulder; and

a screw adapted to engage said internal threads in said implant and insertable through said passageway, said screw comprising a head and a threaded section, said head of screw seats entirely on said shoulder.

25. The support post of Claim 24, wherein said non-round fitting is a boss.

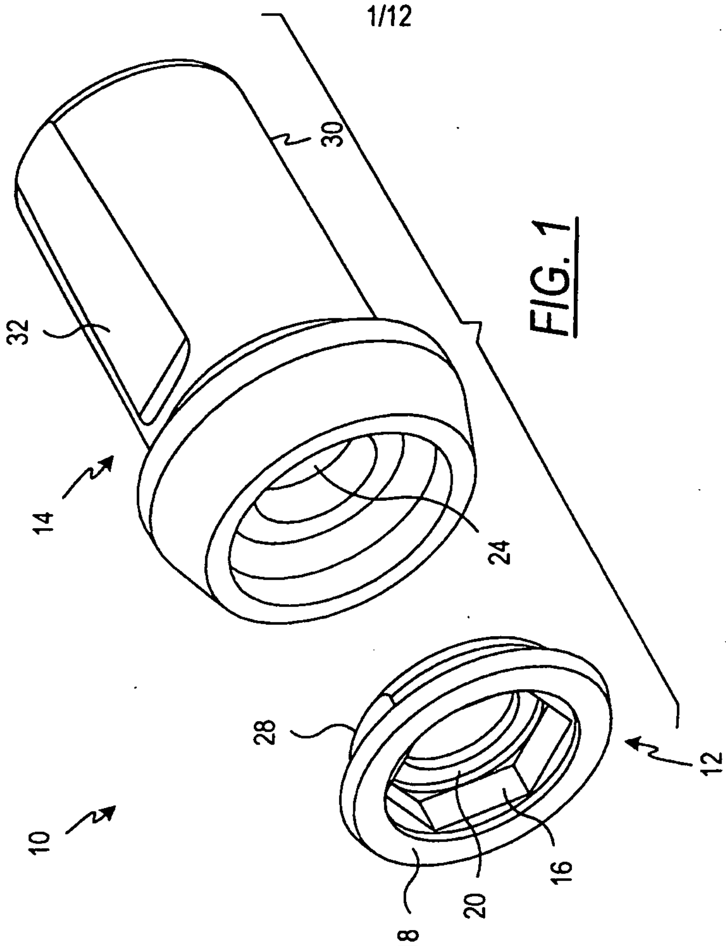

FIG. 1

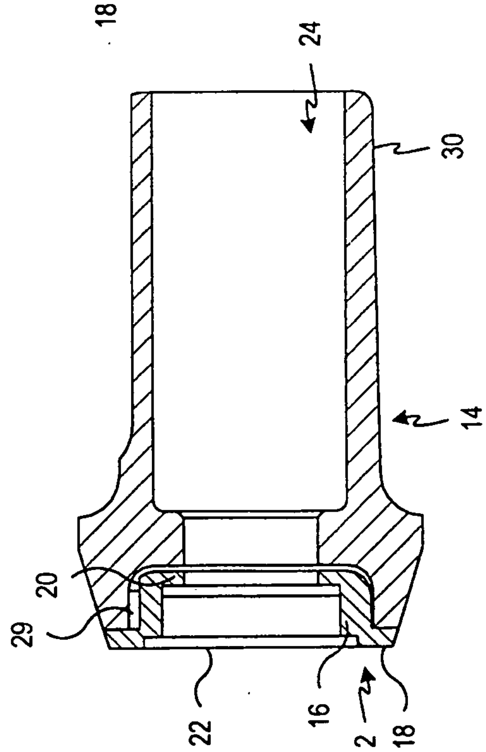

FIG. 2

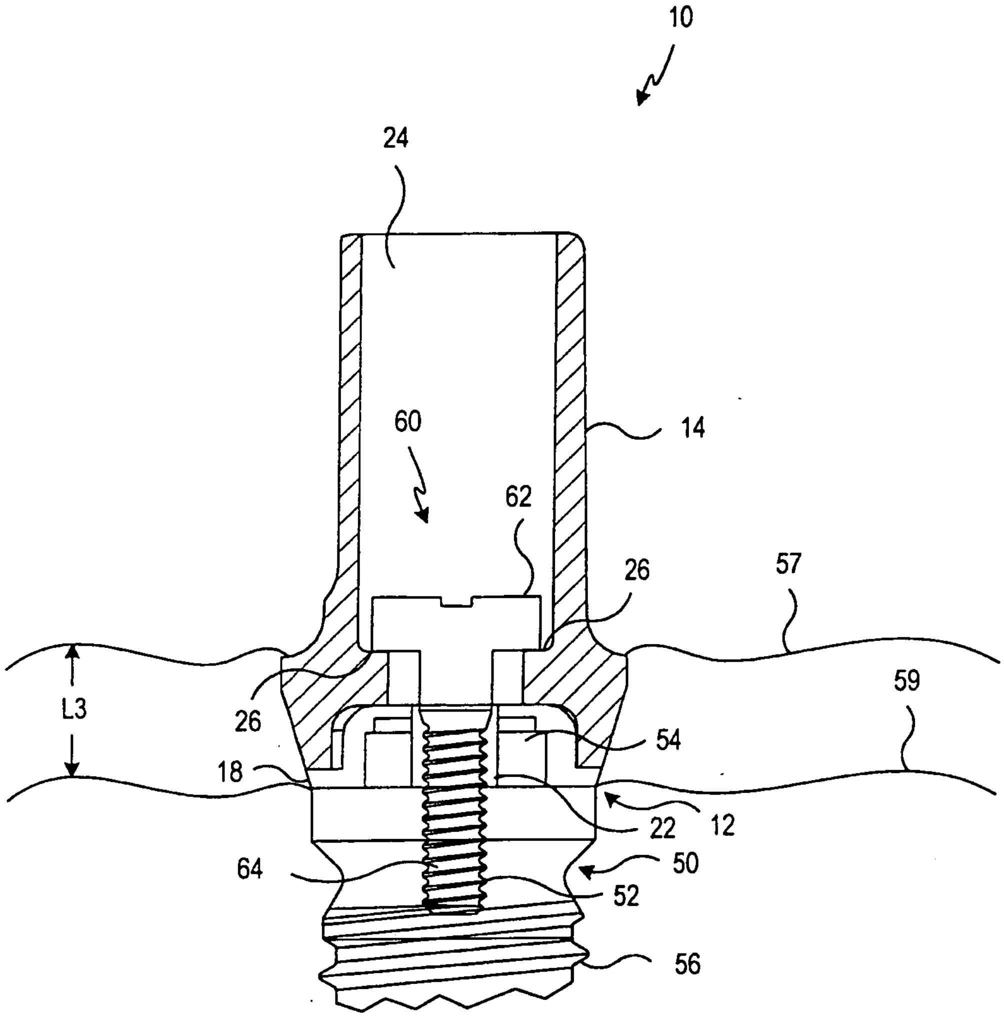

FIG. 3

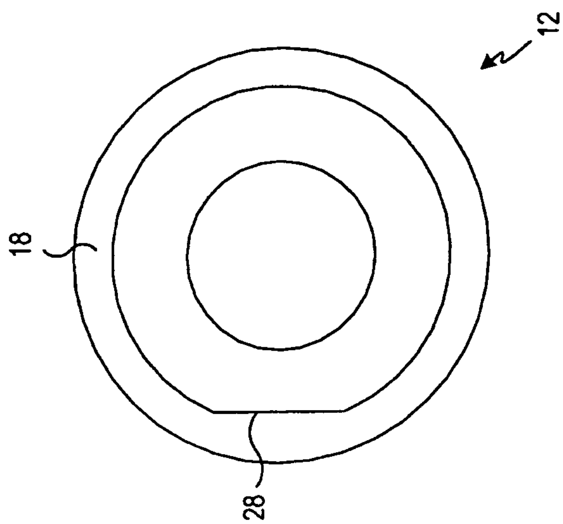

FIG. 5

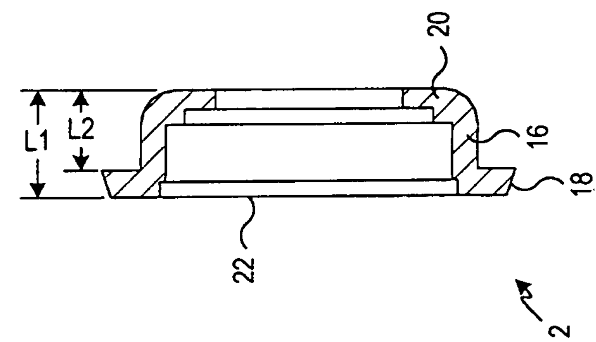

FIG. 4

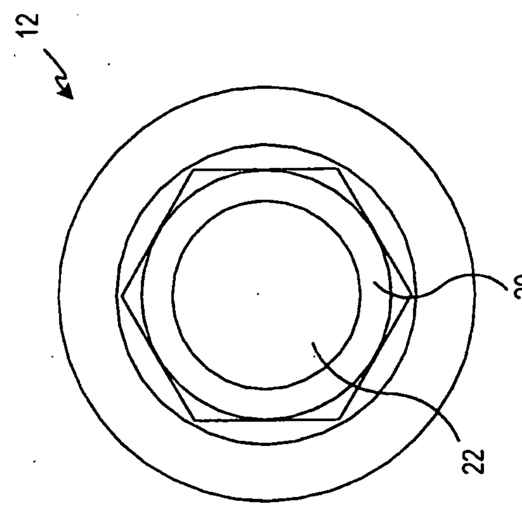

FIG. 6

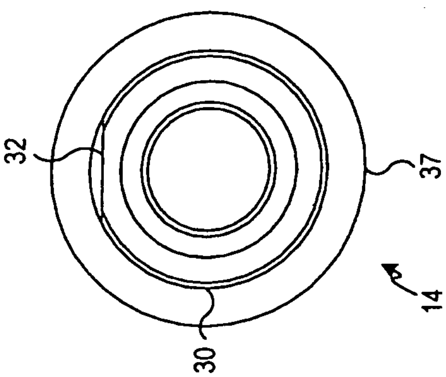

FIG. 8

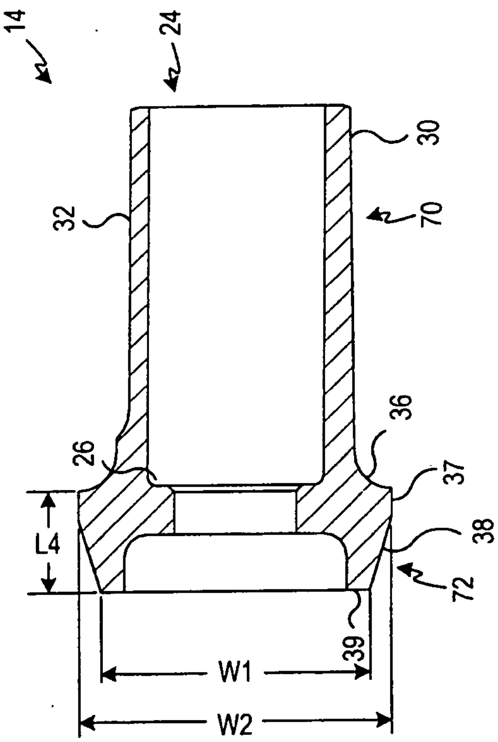

FIG. 7

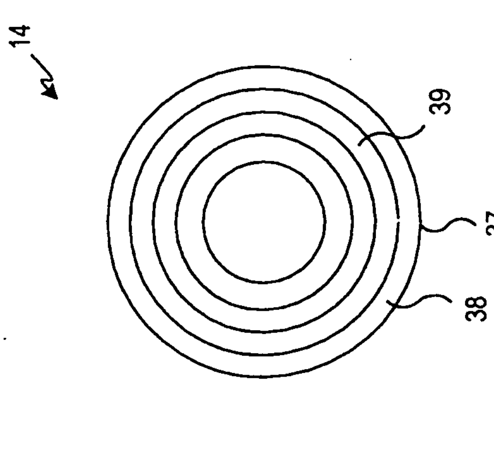

FIG. 9

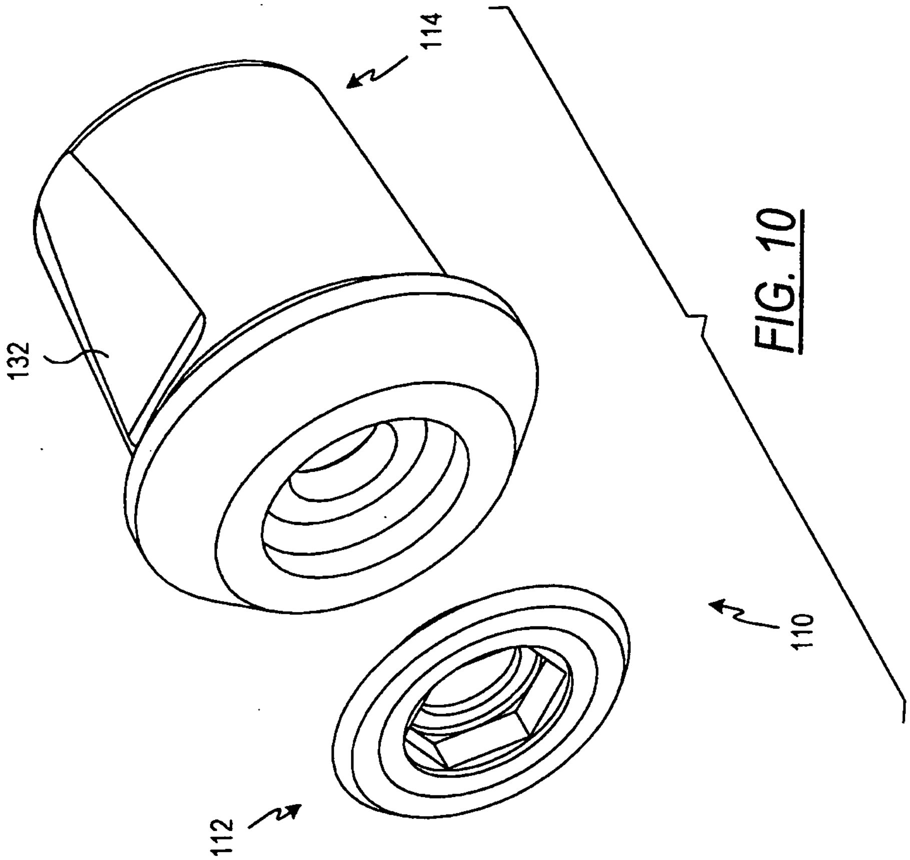

FIG. 10

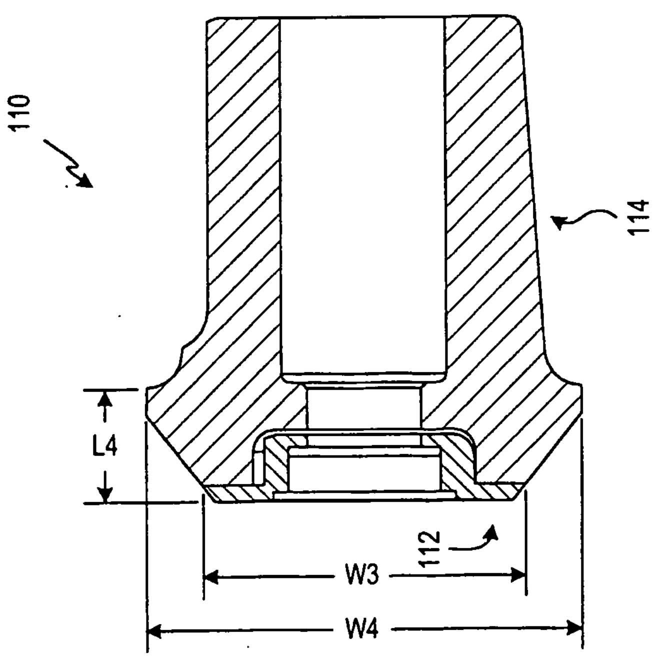

FIG. 11

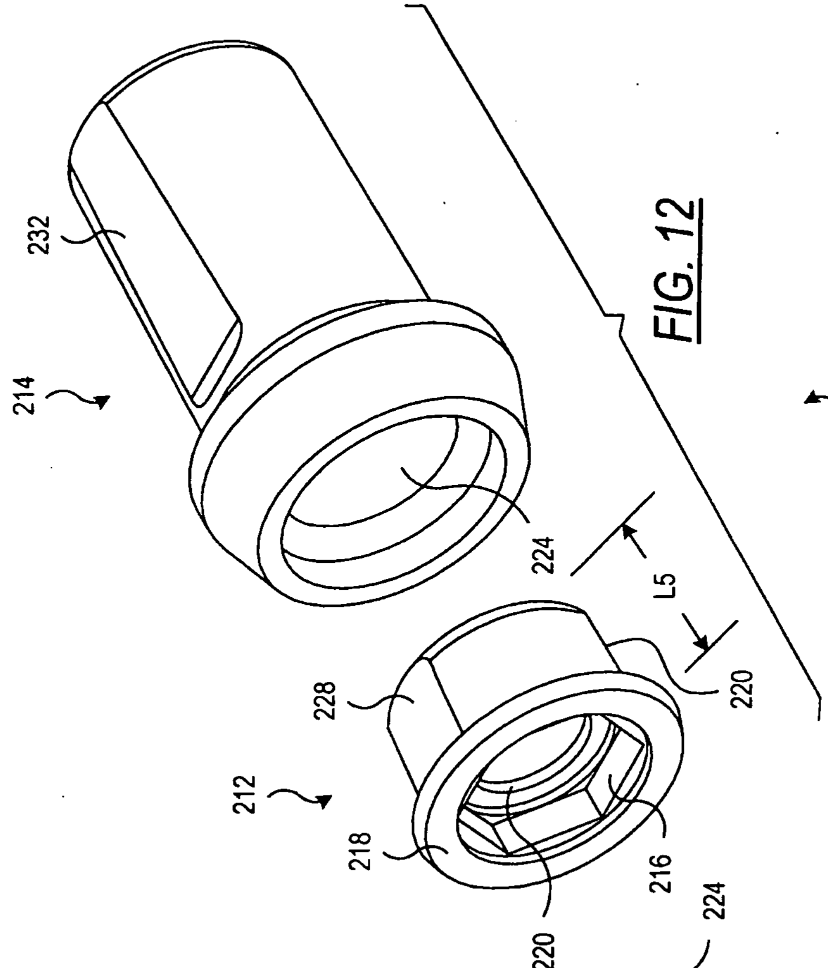
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FIG. 12

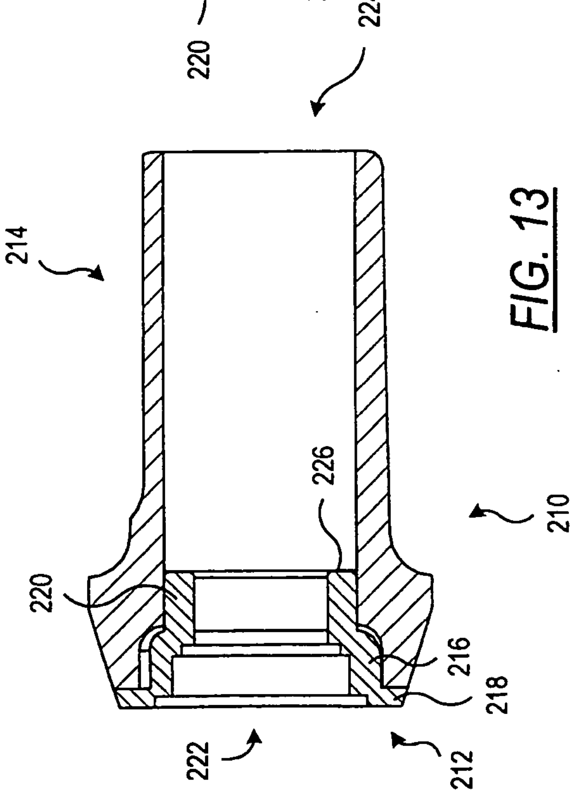
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FIG. 13

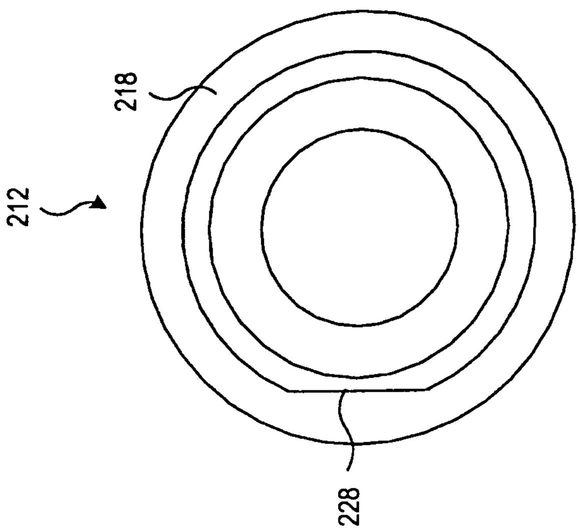

FIG. 15

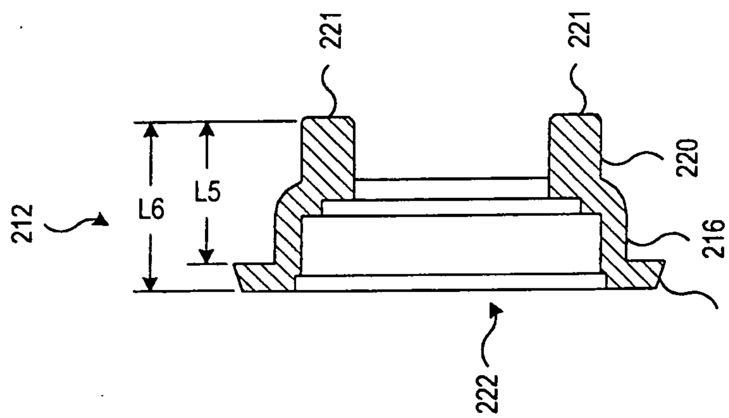

FIG. 14

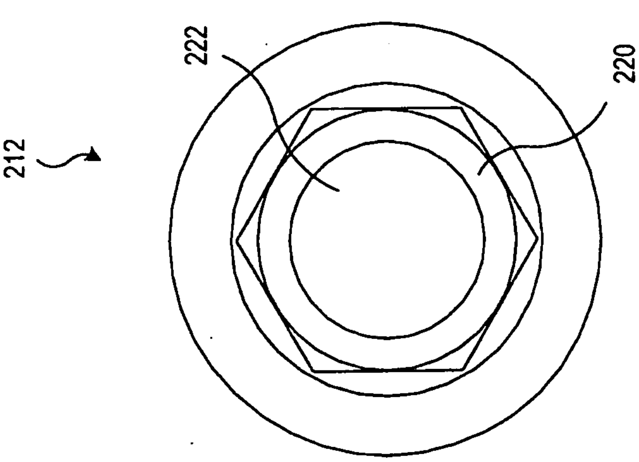

FIG. 16

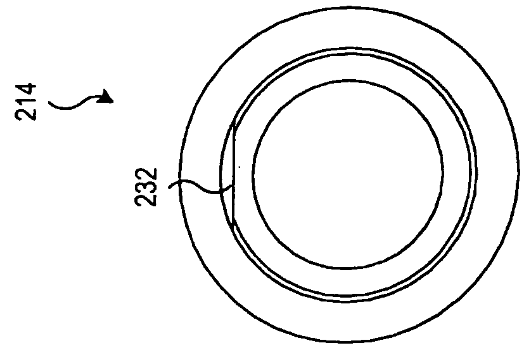

FIG. 18

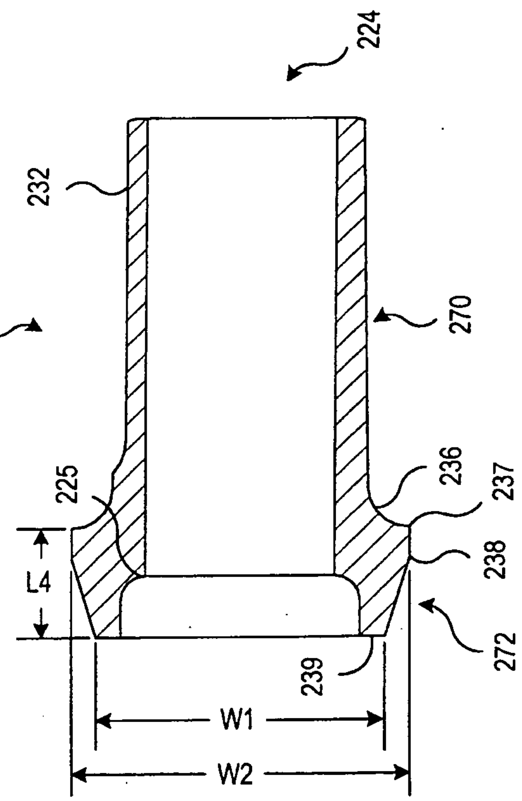

FIG. 17

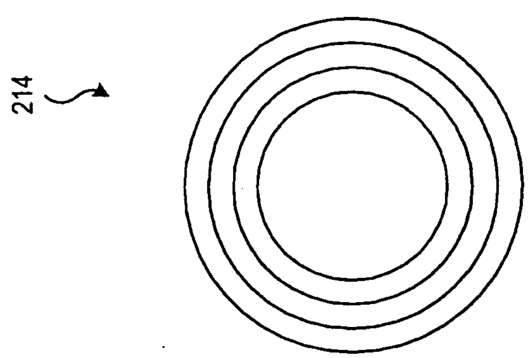

FIG. 19

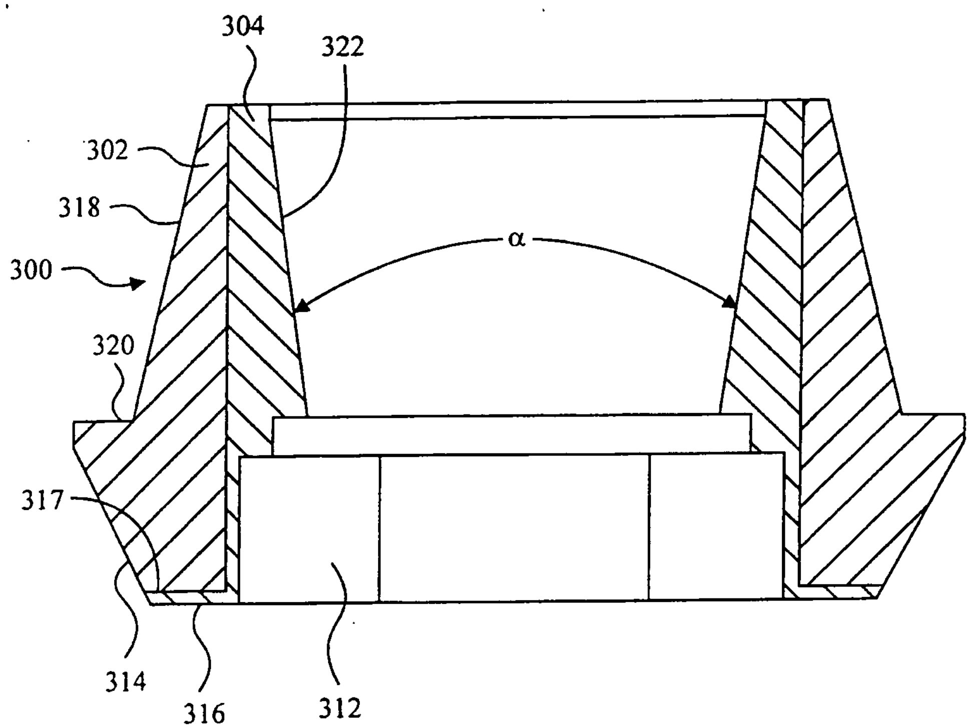

FIG. 20

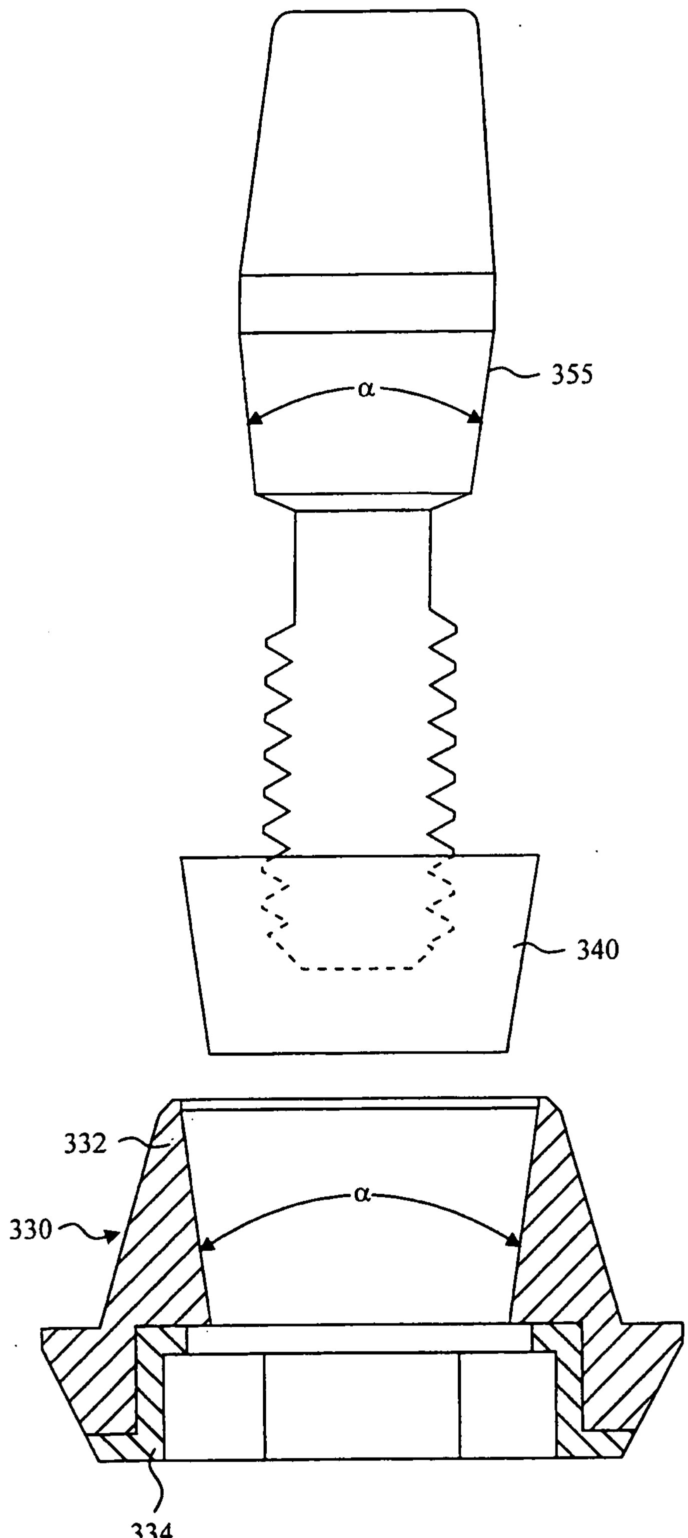

FIG. 21

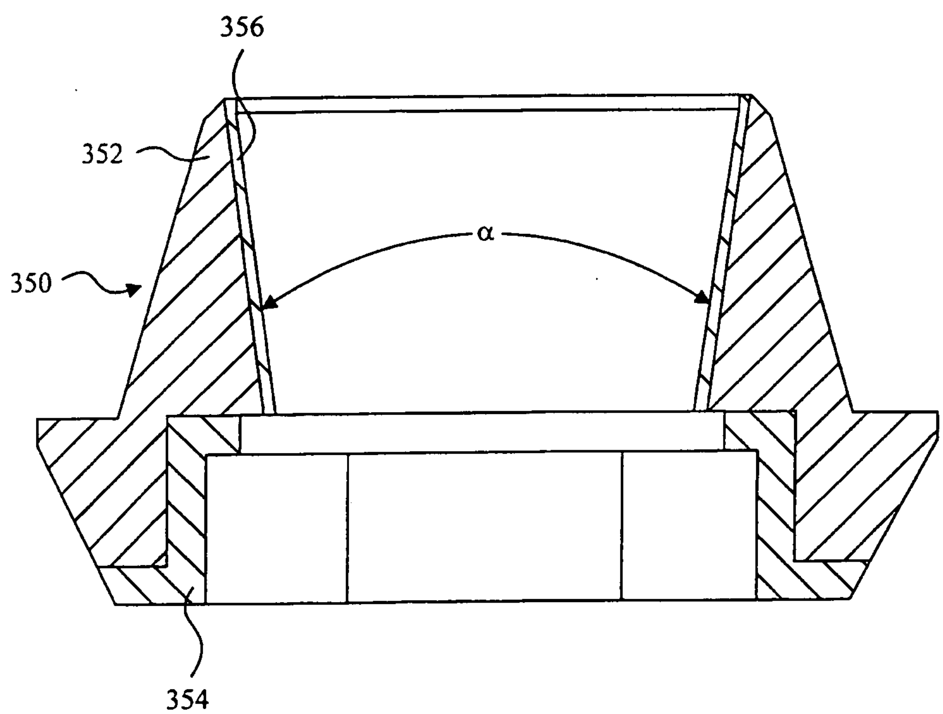

FIG. 22

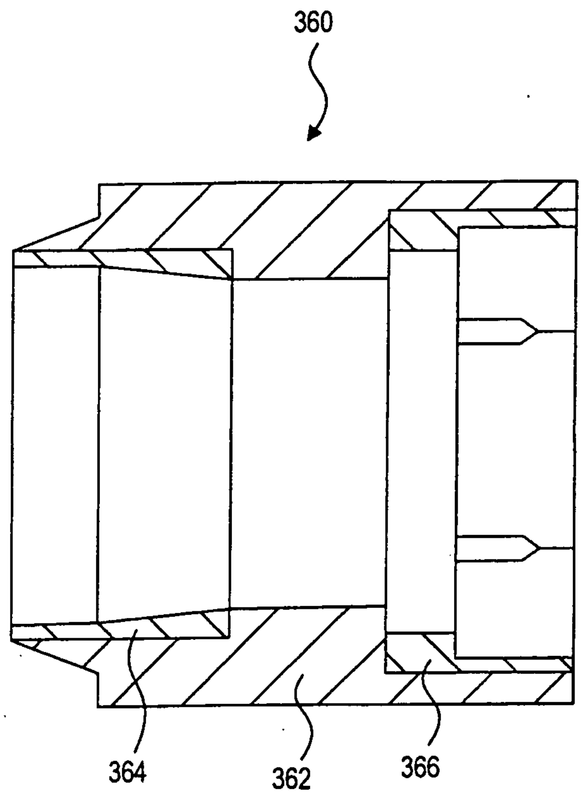

FIG. 23

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/24886

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61C8/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 685 714 A (LAZZARA RICHARD J ET AL) 11 November 1997 (1997-11-11) column 3, line 40 -column 4, line 26 figures 2-4	1,2,4,6, 8-13, 20-25
A		3,7,18, 19
X	US 5 447 435 A (BRODBECK URS) 5 September 1995 (1995-09-05) column 3, line 29-39 figure 2	1,10-13, 20,22-25
A		18,19
A	WO 97 14372 A (IMPLANT INNOVATIONS INC) 24 April 1997 (1997-04-24) page 3, line 11-14 figures 1,2	5,14-17

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 April 2000	14/04/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Chabus, H

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/24886

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5685714 A	11-11-1997	US 5947732 A	07-09-1999
US 5447435 A	05-09-1995	DE 4230009 A	01-04-1993
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